Carhart's notch

Its implications

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Authors

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Abstract

Carhart's notch is classically seen as a dip centered around 2 kHz range of bone conduction curve audiometery. This feature is seen in patients with otosclerosis. This article attempts to discuss why this dip is caused in the bone conduction audiometry curve in these patients.

Carhart's notch

Introduction:

This is seen in bone conduction audiograms of patients with otosclerosis [1]. This is a dip at 2000 Hz in the bone conduction audiograms of these patients. Some authors consider this to be an artifact. After stapes surgery there is demonstrable over closure of air bone gap. There is also effective improvement in the patient's level of hearing at 2 KHz frequency levels.

Discussion:

Audiogram in airconduction shows a decrease in air conduction at all frequencies. Carharts notch [2]is actually a decrease in bone conduction of 10-15 dB seen around 2 kHz frequency. Bone conduction actually means sensorineural reserve. After successful stapes surgery the carharts notch disappears when the conductive hearing improves. This fact shows that carharts notch in no way represents sensorineural reserve of a patient. It is hence considered to be an arifact due to stapes fixation. This phenomenon was first described by Raymond Carhart in 1950. He attributed this phenomenon to stapes fixation. According to Tondroff carharts notch is not a true indication of cochlear reserve since it could be corrected by successful stapes surgery.

The frequency of resonance of middle ear has been identified as 800 – 1200 Hz [3]. Considering this to be a fact then one vital question about carhart's notch remain unanswered " Why is the dip seen at 2 kHz instead of 1200 Hz?" The answer to this question was provided by Zwislocki in 1957. He was able to demonstrate clearly that the primary resonance frequency for ossicular chain bone conduction falls between 1600 – 1700 Hz [4].

Homma's study [5]:

In his classic study Homma published his findings which suggests that middle ear ossicle resonances for air and bone conduction are slightly different. Measurements of ossicle resonances demonstrated that they show two modes of vibration.

Mode 1: This mode is the primary mode for air conduction. The peak occurs around 1200 Hz. This vibration is caused by hinging movement of ossicles due to air conduction stimulus at the level of umbo of ear drum.

Mode 2: This mode has a peak around 1700 Hz. This is caused by pivoting motion of malleus and incus complex. This mode is less robust when compared to that of Mode 1 but is dominant one during bone conduction of sound. Decreased mobility of ossicles in this mode caused due to otosclerosis is considered to be the cause for carhart's notch.

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Tondroff hypothesis[6]:

When skull is vibrated by bone conduction, sound is transferred to cochlea via three routes. i.e.

1. By direct vibration of skull

2. By vibration of ossicular chain which is suspended within the skull

3. By transmission via external auditory canal (normal route)

In conductive hearing loss routes 2 and 3 are affected, but can be regained following successful stapes surgery. Hence bone conduction thresholds improve around 2 KHz frequency range.

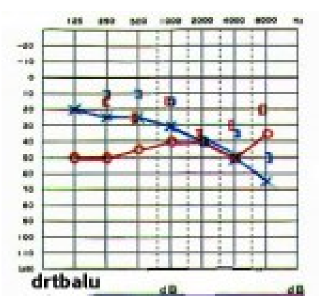

Figure showing carhart's notch

References

1. http://books.google.co.in/books?id=JO7xvVft4YoC&lpg=PP1&pg=PP1#v=onepage&q&f=false

2. Carhart R. The clinical application of bone conduction audiometry. Arch. Otolaryngol. 1950;51:798–808

3. Margolis, R. H., Van Camp, J., Wilson, R.H., & Creten, W.L. (1985). Multifrequency tympanometry in normal ears. Audiology, 24, 44-53.

4. http://www.audiologyonline.com/askexpert/display_question.asp?question_id=636

5. Homma, K., Du, Y., Shizmu, Y., & Puria, S. (2009). Ossicular resonance modes of the human middle ear for bone and air conduction. Journal of the Acoustical Society of America, 125, 968-979.

6. Tonndorf, J. (1971). Animal experiments in bone conduction: Clinical conclusions. In I.M. Ventry, J.B. Chaiklin, & R.F. Dixon (Eds.), Hearing measurement: A book of readings (pp. 130-141). New York, NY: Appleton-Century-Crofts.